TREE-RING DATING OF COSEISMIC COASTAL SUBSIDENCE IN THE PACIFIC NORTHWEST REGION

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Investigation Undertaken: This study was undertaken to determine the date of the most recent great subduction earthquake(s) in the Cascadia region and the extent of area affected in order to estimate the magnitude(s). Also, submerged trees in Lake Sammamish, Washington were studied to see if the landslide that emplaced them in the lake was related to the earthquake on the Seattle fault about 1,000 years ago.

Results:

Coastal Subduction Earthquakes:

The most recent date for an earthquake producing subsidence along at least 100 km of the Washington coast has been established by our tree-ring analysis as between the growing seasons of 1699 and 1700 (Jacoby et al., 1997). Our result is in agreement with the tsunami hypothesis of Satake et al. (1996).

The latest continued research effort concentrated on the southern portion of Cascadia. to try and determine the extent of the earthquake or if there was an earthquake in the southern region of different timing. We visited the Sixes River area being studied by Harvey Kelsey where he had discovered buried roots and stump remnants of trees buried in the sediments near the mouth of the river.

Several cross sections were cut from roots of the remnant stumps. Almost the entire tree above the root collar is decayed away. There were few roots where we could be sure we had the outermost annual ring intact. However, for each individual tree there appeared to be at least one section or place on a section where the last ring was intact. The key process

involved to determine when the trees died is crossdating. This process involves the use of graphical plots of annual ring-width variations, statistical comparisons of series of measured annual ring widths, and direct comparison of rings under microscopic inspection to determine actual calendar dates or relative dates of ring formation in all samples. The roots were crossdated within each tree and then crossdated with the other trees. We also tried to match or crossdate the series of ring widths with living trees to try and determine the year of tree death.

Roots from seven different trees were sampled and processed to yield relative dates for the outer rings which are considered to be the year, or just prior to, the year of death. The dating of these rings is relative to each other and not calendar years. We assigned the last ring of the first tree to be 1501. This is an arbitrary number, not a calendar date. From this base, the last rings extend from 1443 to 1543 with no clustering in time of the last ring of growth. We also checked for evidence of concurrent trauma among the trees. There was no obvious time at which the trees had concurrent growth anomalies that would indicate simultaneous disturbance.

The remnants of the trees are found buried in sediments in what is now a dynamic fluvial environment. They grew in a loamy soil and radiocarbon dating place them in the range of 150 to 480 year before 2,000 AD (Kelsey et al., 1998). The tree-ring dating indicates that the seven trees died over the course of a century. The oldest root indicates one tree was just over 250 years old when it died. This was evidently a stand of mature Sitka spruce trees with some smaller trees as an understory. We sampled some of the roots of the smaller trees but they were of little value with insufficient number of rings far dating. Roots from a total of 11 trees were sampled and increment cores were taken from 4 living or recently killed trees.

Other samples were taken of trees that died some time in the past due to burial or inundation. At Bandon Marsh, Oregon, cores were taken from roots of 6 different trees. Up river from the Bandon Marsh at an embankment near Prosper, root sections were taken from 4 different trees. The samples crossdate within individual locations and to a limited degree between locations.

At this point there is no evidence from these particular tree samples of an earthquake but the analyses are continuing and comparisons being made to other subfossil and living trees in the area. The trees do crossdate, indicating growth during concurrent periods but thus far there in no convergence in time of dates for either death or for evidence of disturbance.

Lake Sammamish:

Lake Sammamish lies on the extended projection of the west-east trending Seattle fault. Samples were obtained by divers from 13 trees submerged in the lake. Most were roots or small trees partially buried in the mud. Many had few rings and decayed outer surfaces. Only one mature tree section with part of the outer ring intact was obtained. This sample crossdated with our previous samples from Lake Washington. Its last ring matches the last ring of the Lake Washington trees but the tree shows evidence of trauma for the last two years and the last ring does not show a complete growth for a normal year. The anatomy indicates initiation of trauma two growing seasons before the tree died. An interpretation would be very speculative with just one dated sample.

Reports:

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